REMARKS

The Applicant notes the Examiner's acknowledgment of Applicant's election of species A as illustrated in Figure 1. The Examiner has withdrawn claims 5, 7 and 12-20 from further consideration as being drawn to a nonelected species. The Examiner has rejected claims 1-13 and 21. Claims 1, 2, 4, 6, 7, 8, 10 and 21 have been amended. New claims 22-38 have been added. Claims 1-13 and 21-38 remain for consideration.

Claim rejections - 35 U.S.C. §103

Fox et al. (USPN 5,285,347) in view of Hamilton et al. (5,901,037)

The Examiner has rejected claims 1-3, 6, 8-11 and 21 as being unpatentable over Fox et al. in view of Hamilton et al. The Examiner states that the patent of Fox et al. in figures 1-6 discloses all the claimed features of the invention with the exception of the channels being micro-channels and inlet and outlet end caps. The Examiner further stated that, "method of manufacturing limitations (i.e. molding, extruding, etc.) are not given any patentable weight in an apparatus claim.

The Examiner states that the patent of Hamilton et al. in Figures 12-13 discloses a heat exchanger having a plurality of micro-channels and inlet and outlet end caps for the purpose of increasing the heat transfer rate away from an electronic device and increasing the heat transfer efficiency of the heat exchanger.

The Examiner concludes that, "It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ in Fox et al. the heat exchanger having a plurality of microchannels and inlet and outlet end caps for the purpose of increasing the heat transfer rate away from an electronic device and increasing the heat transfer efficiency of the heat exchanger as disclosed in Hamilton et al.

Regarding claim 1, claim has been amended to add the limitation of :

A cooling apparatus . . . comprising:

a low profile metal [extrusion] unitary member having a first exterior [extrusion] surface adapted for receiving heat from the at least one heat generating component and a plurality of micro tubes having a flattened heat transfer surface, said low profile metal unitary member having [with] a micro tube inlet and a micro tube outlet, said low profile metal [extrusion] unitary member providing an entirely metallic thermal path for conducting heat from said first exterior [extrusion] surface to a heat transfer fluid contained within said plurality of micro tubes;

The term "extrusion" has been deleted due to the Examiner's statement that such limitations are not given any patentable weight in an apparatus claim. The limitation, "unitary member" has been added to the claim to claim the advantageous nature of the extruded part, which makes possible a low profile and other advantages. Additionally, the limitation that the, "plurality of micro tubes having a flattened heat transfer surface" has been added to provide claims of differing scope.

Fox et al. teaches a hybrid heat sink 20 to be placed in direct physical contact with an electronic component 14 as is shown in figures 1 and 2 (see col. 5, lines 26-28). Heat sink 20 may be manufactured by a casting process wherein heat sink 20 is cast in two sections that are joined along line 40 (see col. 5, lines 48-51). In an alternate configuration, shown in figure 2, the hybrid heat sink could be manufactured by drilling holes 80, 82, 84, and 86 through the body of the hybrid heat sink 20. Fittings 60, 62, 64, 66, 68, 70, 72 and 74are attached by brazing or welding. Flexible tubing 90 is then attached to the fittings, thereby allowing a path of the fluid to flow through the hybrid heat sink 20.

In either embodiment of the heat sink 20 taught in Fox et al., the heat sink 20 is not comprised of a unitary member with micro tubes having a flattened heat transfer surface as is claimed in amended claim 1. In the first embodiment, heat sink 20 is cast in two sections, which are joined along line 40. Cavity 16 appears to have a circular cross-section in Figure 1. Additionally, the heat sink 20 is not comprised of a unitary member, but instead is bifurcated so that the cavity 16 may form a passageway when the two sections are mated along line 40.

In the alternate embodiment shown in Figure 2, the heat sink 20 is comprised of a unitary member, but the passageways are formed by drilling holes 80, 82, 84, and 86 through the body of the heat sink 20 (col. 5, lines 57 and 58). Since holes 80, 82, 84, and 86 are drilled, the holes must have a circular cross section.

Hamilton et al. teaches a micro channel cooled high power RF transistor amplifier module 10 (figure 10) comprised of a substrate 14 including a plurality of parallel micro channel grooves 16 that form micro channels when substrate 14 is mated up with channel closure member 26. Hamilton does not teach a unitary member with micro tubes having a flattened heat transfer surface as is claimed in amended claim 1.

Neither Fox et al. nor Hamilton et al. teach or suggest, alone or in combination, a unitary member with micro tubes having a flattened heat transfer surface as is claimed in amended claim 1.

Dependent claim 2 depends from independent claim 1, which is submitted to be patentable. Dependent claim 2 is, therefore, submitted to be patentable for at least this reason.

Regarding dependent claim 4, claim 4 has been amended to conform with the language of claim 2. Additionally, dependent claim 4 depends from dependent claim 2, which depends from

independent claim 1, which is submitted to be patentable. Dependent claim 4 is, therefore, submitted to be patentable for at least this reason.

Regarding dependent claims 6 and 7, dependent claims 6 and 7 have been amended to replace "low profile metal extrusion" with "low profile metal member" to conform with the amended language of independent claim 1. Dependent claims 6 and 7 depend from independent claim 1, which is submitted to be patentable. Dependent claims 6 and 7 are, therefore, submitted to be patentable for at least this reason.

Regarding independent claim 8, independent claim 8 has been amended to include the limitation of "a plurality of fins on an interior surface of at least one of said plurality of micro tubes. Note that several elements of claim 8 have been deleted.

Neither Fox et al. nor Hamilton et al. either teach or suggest placing fins within the micro tubes. Claim 8 is, therefore, submitted to be non-obvious and, therefore, patentable over the cited references. The unitary construction of applicant's low profile metal extrusion allows for the construction of a member having a fin within the micro tubes.

Regarding dependent claim 9, dependent claim 9 depends from independent claim 8, which is submitted to be patentable. Dependent claim 9 is, therefore submitted to be patentable for at least this reason.

Regarding dependent claim 10, dependent claim 10 has been amended to replace "low profile extrusion" with "low profile unitary member" to conform with the amended language of independent claim 8. Dependent claim 10 depends from independent claim 8, which is submitted to be patentable. Dependent claim 10 is, therefore, submitted to be patentable for at least this reason.

Regarding dependent claim 11, dependent claim 11 depends from dependent claim 10, which depends from independent claim 8, which is submitted to be patentable. Dependent claim 11 is, therefore submitted to be patentable for at least this reason.

Regarding independent claim 21, independent claim 21 has been amended to include the limitation that said low profile member has a "unitary" or single piece construction. Further, claim 21 has been amended to state that the member has a profile of approximately 0.01 inches. Neither of the cited references teach or suggest a low profile member having a unitary construction and which possesses a profile of less than 0.1 inches. The additional limitation is supported in the specification on page 12, line 24. Applicants, therefore, request allowance of amended Claim 21.

Claim rejections - 35 U.S.C. §103

Fox et al. (USPN 5,285,347) in view of Hamilton et al. (5,901,037) further in view of known/convention prior art

The Examiner has rejected claim 4, "as being unpatentable over Fox et al. in view of Hamilton et al. as applied to claims 1-3, 6, 8-11 and 21 above, and further in view of applicant's admission of known/convention prior art." The Examiner states that,

> "applicant's admission of known/convention prior art in his specification on page 7 discloses that it is known to have a second material between the heat exchanger and the component of the purpose of reducing thermal resistance and attaching the component to the heat exchanger. The material being metal is considered to be an obvious design expedient. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ in Fox et al. as modified,

a second material between the heat exchanger and the component for the purpose of reducing thermal resistance and attaching the component to the heat exchanger as known by applicant's omission of known/convention prior art."

Regarding dependent claim 4, dependent claim 4 has been amended to replace "low profile metal extrusion" with "low profile metal unitary member" to conform with the amended language of independent claim 1. Dependent claim 4 depends from independent claim 1, which is submitted to be patentable. Dependent claim 4 is, therefore, submitted to be patentable for at least this reason.

New Claims

Applicants have added new claims 22-38 to the application to claim additional subject matter.

For the reasons set forth above, Applicants therefore respectfully request the thorough reconsideration of this application and earnestly solicit an early Notice of Allowance.

Respectfully submitted,

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Re-written mark-ups to show changes after Preliminary Amendment:

In the Title:

Please delete "Cooling Apparatus Having Low Profile Extrusion and Method of Manufacture Therefor" and change to --Cooling Apparatus Having Low Profile Extrusion --.

In the Claims:

1. (Twice amended) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile metal [extrusion] unitary member having a first exterior [extrusion] surface adapted for receiving heat from the at least one heat generating component and having a plurality of micro tubes having a flattened heat transfer surface, said low profile unitary member having [with] a micro tube inlet and a micro tube outlet, said low profile metal [extrusion] unitary member providing an entirely metallic thermal path for conducting heat from said first exterior [extrusion] surface to a heat transfer fluid contained within said plurality of micro tubes;

an inlet tube;

and inlet end cap interconnecting the micro tube inlets in fluid communication and connecting the micro tube inlets in fluid communication with said inlet tube;

an outlet tube;

an outlet end cap interconnecting the micro tube outlets in fluid communication and connecting the micro tube outlet in fluid communication with said outlet tube;

means for circulating said heat transfer fluid through said inlet tube, said inlet end cap, the plurality of micro tubes of said low profile extrusion, said outlet end cap, and said outlet tube; and

means for removing heat from said heat transfer fluid.

2. (Amended) The cooling apparatus of claim 1, wherein said low profile metal [extrusion] member is formed of a first metal material.

3. The cooling apparatus of claim 2, wherein said first metal material is in thermal contact with said at least one heat generating component, and said first metal material is further in direct contact with said heat transfer fluid.

4. (Amended) The cooling apparatus of claim 2, wherein said low profile metal [extrusion] member is plated on an exterior surface with a second metal material.

5. The cooling apparatus of claim 1, further comprising at least one thermoelectric cooling unit disposed between said at least one heat generating component and said first exterior extrusion surface.

6. (Amended) The cooling apparatus of claim 1, wherein said low profile metal [extrusion] member further comprises a plurality of fins on a second exterior surface opposite said first exterior [extrusion] surface adapted for receiving heat.

7. (Amended) The cooling apparatus of claim 1, wherein said low profile metal [extrusion] member further comprises a plurality of fins or grooves on an interior surface of each of said plurality of micro tubes.

8. (Amended) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile [extrusion] unitary member having a flattened exterior extrusion surface adapted for receiving heat from the at least one heat generating component and a plurality of micro tubes with a micro tube inlet and a micro tube outlet; [, said low profile extrusion having a flattened interior extrusion surface forming a portion of each of said plurality of micro tubes]

at least one fin on an interior surface of at least one of said plurality of micro tubes;

[an inlet tube;

and inlet end cap interconnecting the micro tube inlets in fluid communication and connecting the micro tube inlets in fluid communication with said inlet tube;

an outlet tube;

an outlet end cap interconnecting the micro tube outlets in fluid communication and connecting the micro tube outlet in fluid communication with said outlet tube;

a heat transfer fluid;]

means for circulating a [said] heat transfer fluid through said [inlet tube, said inlet end cap, the] plurality of micro tubes of said low profile [extrusion] member[, said outlet end cap, and said outlet tube]; and

means for removing heat from said heat transfer fluid.

9. The cooling apparatus of claim 8, wherein each of said micro tubes are substantially rectangular in shape.

10. (Amended) The cooling apparatus of claim 8, wherein said low profile [extrusion] member is formed of a metal material.

11. The cooling apparatus of claim 10, wherein said metal material is in thermal contact with said at least one heat generating component, and said metal material is further in direct contact with said heat transfer fluid.

12. The cooling apparatus of claim 8, further comprising at least one thermoelectric cooling unit disposed between said at least one heat generating component and said first exterior extrusion surface.

13. (Amended) The cooling apparatus of claim 8, wherein said low profile extrusion further comprises [a plurality of fins or grooves] at least one fin on an interior surface of each of said plurality of micro tubes.

21. (Amended) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile metal [extrusion] unitary member having a first exterior extrusion surface adapted for receiving heat from the at least one heat generating component and a plurality of micro tubes with a micro tube inlet and a micro tube outlet, said low profile metal [extrusion] unitary member providing an entirely metallic thermal path for conducting heat from said first exterior extrusion surface to a heat transfer fluid contained within said plurality of micro tubes, said member having a profile of less than approximately 0.1 inches;

and inlet end cap interconnecting the micro tube inlets in fluid communication;

an outlet end cap interconnecting the micro tube outlets in fluid communication;

means for circulating said heat transfer fluid through said inlet end cap, the plurality of micro tubes of said low profile extrusion and said outlet end cap; and

means for removing heat from said heat transfer fluid.

22. (New) The cooling apparatus according to claim 21 wherein:

said cooling apparatus is affixed to a printed circuit board for cooling said heat generating component.

23. (New) The cooling apparatus according to claim 1 wherein:

said cooling apparatus is affixed to a printed circuit board for cooling said heat generating component.

24. (New) The cooling apparatus according to claim 8 wherein:

said cooling apparatus is affixed to a printed circuit board for cooling said heat generating component.

25. (New) The cooling apparatus according to claim 1, wherein said micro tubes are polygonal in cross section.

26. (New) The cooling apparatus according to claim 1, wherein said micro tubes are substantially square in cross section.

27. (New) The cooling apparatus according to claim 8, wherein said micro tubes are polygonal in cross section.

28. (New) The cooling apparatus according to claim 8, wherein said micro tubes are substantially square in cross section.

29. (New) The cooling apparatus according to claim 21, wherein said micro tubes are polygonal in cross section.

30. (New) The cooling apparatus according to claim 1, wherein said micro tubes are substantially square in cross section.

31. (New) The cooling apparatus according to claim 21, wherein said micro tubes are substantially square in cross section.

32. (New) The cooling apparatus according to claim 1 wherein:
said member has a profile of approximately 0.1 inches.

33. (New) The cooling apparatus according to claim 8 wherein:
said member has a profile of approximately 0.05 inches.

34. (New) The cooling apparatus according to claim 1 wherein said micro tubes have a diameter of between approximately .0625 inches and 0.5 inches.

35. (New) The cooling apparatus according to claim 8 wherein said micro tubes have a diameter of between approximately .0625 inches and 0.5 inches.

36. (New) The cooling apparatus according to claim 21 wherein said micro tubes have a diameter of between approximately .0625 inches and 0.5 inches.

37. (New) The cooling apparatus according to claim 21 wherein said low profile is approximately 0.05 inches.

38. (New) The cooling apparatus according to claim 21 further comprising:

at least one fin on an interior surface of each of said plurality of micro tubes.